ANNUAL REPORT FOR 2005

Marks Creek Stream Mitigation Site
Wake County
WBS Element 34455.4.2
TIP No. R-2547WM

Prepared By:
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North Carolina Department of Transportation
December 2005

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SUMMARY

The following report summarizes the stream monitoring activities that have occurred during the Year 2005 at the Marks Creek Site in Wake County. This site was designed and constructed during 2002 by North Carolina Department of Transportation (NCDOT). This report provides the monitoring results for the second formal year of monitoring (Year 2005). Monitoring will continue at this site for another three years or until all success criteria are satisfied.

Based on the results obtained as part of the Year 2005 monitoring activities, the Marks Creek Site continues to function within the capacity for which it was designed. Significant problems were endured during 2003 as a result of erosion control problems associated with the construction of the US 64 Knightdale Bypass, immediately upstream of the project area. All five unnamed tributaries were inundated with sediment. NCDOT postponed the Year 2003 monitoring to allow the site to stabilize. Formal monitoring was initiated in 2004. According to the data collected in 2005, areas of deposition and scour continue to exist along the North, West, Southwest, and Main Tributaries; however, these areas remain localized and do not appear to be compromising the overall functions of the site. Due to the abnormally low amounts of precipitation experienced during 2005, excessive sediment was noted along portions of the South Tributary, which remains consistent with the data collected in 2004. It is anticipated that future bankfull events will help to move this sediment through the system. Overall, the system remains intact. No remedial work is proposed or needed at the current time.

Based on the information obtained from the USGS, the Marks Creek Site has met the required monitoring protocols for hydrology as it relates to bankfull events. At least two bankfull events have occurred on site since the time of construction.

Based on the data collected in 2005, the Marks Creek Site continues to improve in overall quality and function. An on-site agency meeting was held in August 2005 to review the site. During the on-site meeting, the stream mitigation portion of the project was discussed. No problems were currently noted with respect to the stream channels and NCDOT will continue to monitor the site.

1.0 INTRODUCTION

1.1 Project Description

The following report summarizes the stream monitoring activities that have occurred during the Year 2005 at the Marks Creek Mitigation Site. The site is situated east of and immediately adjacent to the right-of-way associated with the recently completed US 64 Knightdale Bypass (Figure 1). It is located approximately 8.0 miles (12.9 kilometers) east of Raleigh in the eastern portion of Wake County. The Marks Creek Site was constructed to provide mitigation for stream impacts associated with the Knightdale Bypass Transportation Improvement Program (TIP) number R-2547/R-2641 in Wake County.

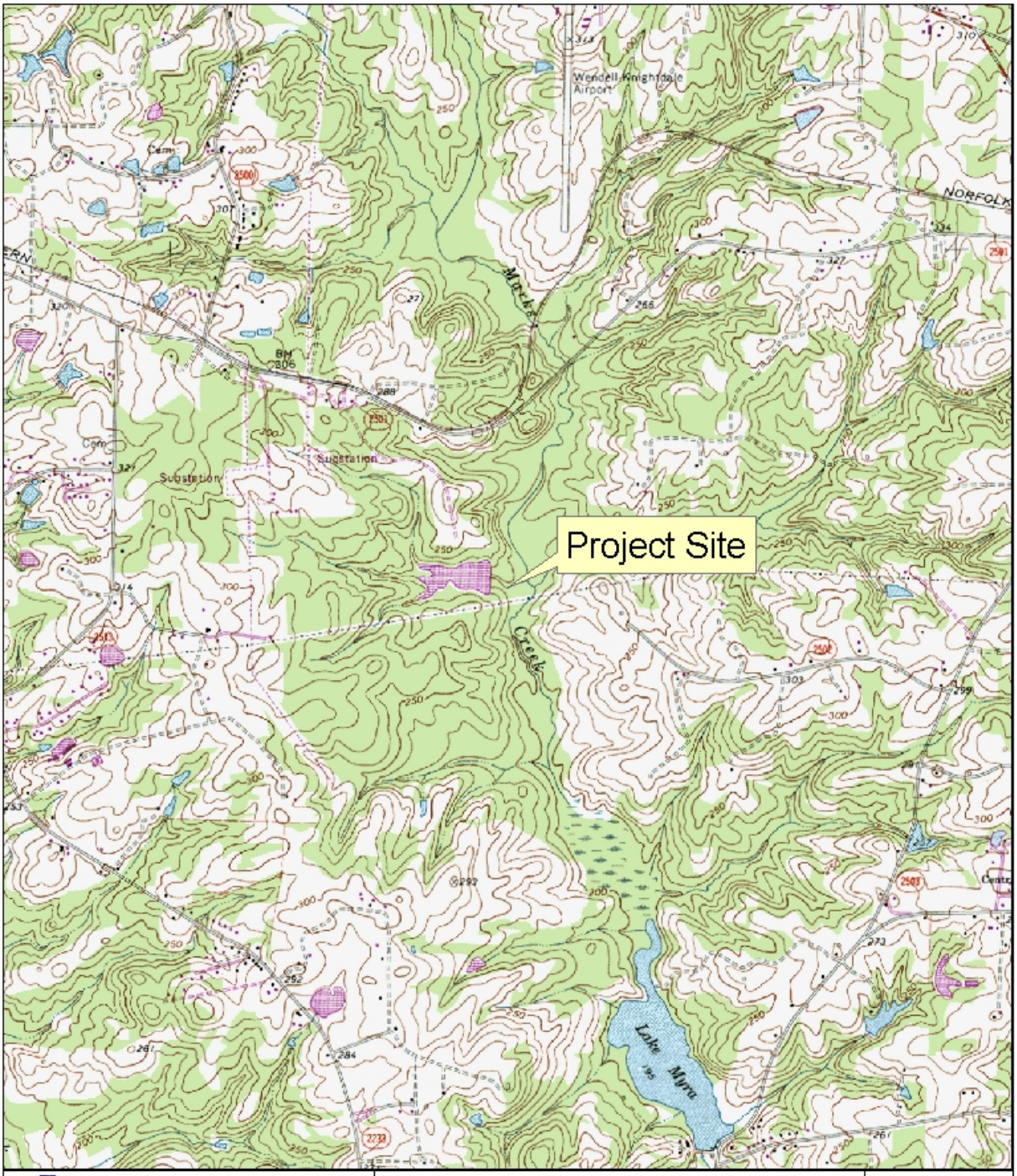
The stream mitigation project involved the restoration of an unnamed tributary to Marks Creek (the Main Tributary to Marks Creek) and four of its tributaries (the North, West, Southwest, and South Tributaries). As part of the project, NCDOT drained an approximately 10-acre pond and removed the dam in its entirety. New channels were constructed as near as practicable to their former locations before initial dam construction was implemented. The reconnection of the Main Tributary to Marks Creek and its tributaries to their original floodplain resulted in the Priority I restoration of approximately 3,200 linear feet. Design and construction was implemented during 2002 by NCDOT. Stream restoration involved the construction of new channels and the installation of rootwads, rock vanes, rock cross vanes and log vanes to control grade and stabilize the channel. It also included the restoration of riparian buffers using native vegetation, as well as the restoration of riverine wetlands.

1.2 Purpose

According to the mitigation plan (NCDOT, 2001) the objectives for this mitigation site were to improve water and riparian quality as well as stability associated with the Main Tributary to Marks Creek and its unnamed tributaries.

Successful stream mitigation is demonstrated by a stable channel that does not aggrade or degrade over time. It is also demonstrated by reduced erosion rates, the permanent establishment of native vegetation, and bed features consistent with the design stream type. Results of stream monitoring activities conducted during the 2005 growing season at the Marks Creek Site are included in this report.

Activities in 2005 reflect the second formal year of monitoring following the restoration efforts; however, it is the third year since construction. Included in this report are analyses on stability (primarily the longitudinal profile and cross sections) and site photographs.

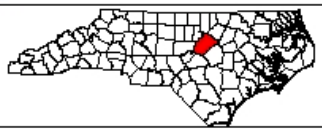


North Carolina
Department of Transportation

PROJECT VICINITY
Marks Creek
Stream and Wetland Mitigation Project
Wake County, North Carolina

Figure No.

1



Map Does Not Reflect Restored Channels 1:24,000

0 750 1,500 3,000 4,500 6,000 Feet

USGS 7.5- Minute Topographic Quadrangles:Knightdale
Contour Interval 10 Feet

1.3 Project History

July to August 2001	Pond Drained.
Late 2002	Restoration Completed.
June 2004	Stream Channel Monitoring (Year 1)
July 2005	Stream Channel Monitoring (Year 2)

During 2003, several heavy rain events caused the existing erosion control devices associated with construction of the Knightdale Bypass to fail immediately upstream of the project site. As a result, the mitigation site was inundated with sediment. NCDOT refrained from conducting formal monitoring during the 2003 growing season until all erosion control devices were corrected and brought back on line with the system. NCDOT conducted its first formal year of monitoring in 2004 to allow the new erosion control devices had been implemented and the streams had time to stabilize.

2.0 STREAM ASSESSMENT

2.1 Success Criteria

The success criteria, as defined by federal guidelines for stream mitigation, includes the following main parameters: no less than two bankfull events for the five-year monitoring period, reference photos, plant survivability analyses, and channel stability analyses (USACE, 2003). Biological sampling was not required for this site.

Natural streams are dynamic systems that are in a constant state of change. Longitudinal profile and cross section surveys will differ from year to year based on changes in the watershed. Natural channel stability is achieved by allowing the stream to develop a proper dimension, pattern, and profile such that, over time, channel features are maintained and the stream system neither aggrades nor degrades. A stable stream consistently transports its sediment load, both in size and type, associated with local deposition and scour. Channel instability occurs when the scouring process leads to degradation, or excessive sediment deposition results in aggradation (Rosgen, 1996). The following surveys were conducted in support of the monitoring assessment:

- Longitudinal Profile Survey. This survey addressed the overall slope of the reach, as well as slopes between bed features. The bed features are secondary delineative criteria describing channel configuration in terms of riffle/pools, rapids, step/pools, cascades and convergence/divergence features which are inferred from channel plan form and gradient. The surveys are compared on a yearly basis to note and/or compare aggradation, degradation, head cuts, and areas of mass wasting. The longitudinal profile is expected to change from year to year. Significant changes may require additional monitoring.

- Cross Section Surveys. These surveys addressed the following characteristics at various locations along the reach: entrenchment ratio, width/depth ratio, and dominant channel materials. The entrenchment ratio is a computed index value used to describe the degree of vertical containment. The width/depth ratio is an index value which indicates the shape of the channel cross section. The dominant channel materials refer to a selected size index value, the D_{50}, representing the most prevalent of one of six channel material types or size categories, as determined from a channel material size distribution index.

2.2 Stream Description

2.2.1 Post-Construction Conditions

The mitigation of all five reaches associated with the project involved the draining of the existing pond and the re-construction of four new channels on site. Within the new channels, j-hook vanes, rock and log vanes, and rootwad revetments were installed. Unfortunately, soon after restoration, the site was inundated with sediment from the construction of the Knightdale Bypass located upstream. This inundation was due to the failure of the erosion sediment control devices. Currently, new devices have been implemented; however the excess sediment is still in the process of being expunged from the system.

2.2.2 Monitoring Conditions

The Main Tributary to Marks Creek, the North Tributary, the West Tributary, the South Tributary, and the Southwest Tributary were designed to be classified as C5 stream type channels according to the Rosgen Classification of Natural Rivers; however only the South Tributary classifies as C5, the remaining tributaries classify as a C4 stream type. A total of sixteen cross sections (four along the Main Tributary to Marks Creek and 12 along its four tributaries) were surveyed. Stream classifications were completed only at the riffle cross sections, consistent with classification protocols established by Dave Rosgen, PhD, PH, Wildland Hydrology, Inc. Figure 2 depicts the channel layout at the site.

2.2.3 Site Photographs

Photo points were established during the 2004 monitoring year along the unnamed tributaries of Marks Creek in order to visually evaluate channel aggradation or degradation, bank erosion, success of riparian vegetation and the effectiveness of erosion control measures. Photographs were taken during the first (Year 2004) and second monitoring years (Year 2005). There are six photo points along the unnamed tributaries, as well as additional overview photographs of the site. The Year 2005 photographs are presented in Appendix A.

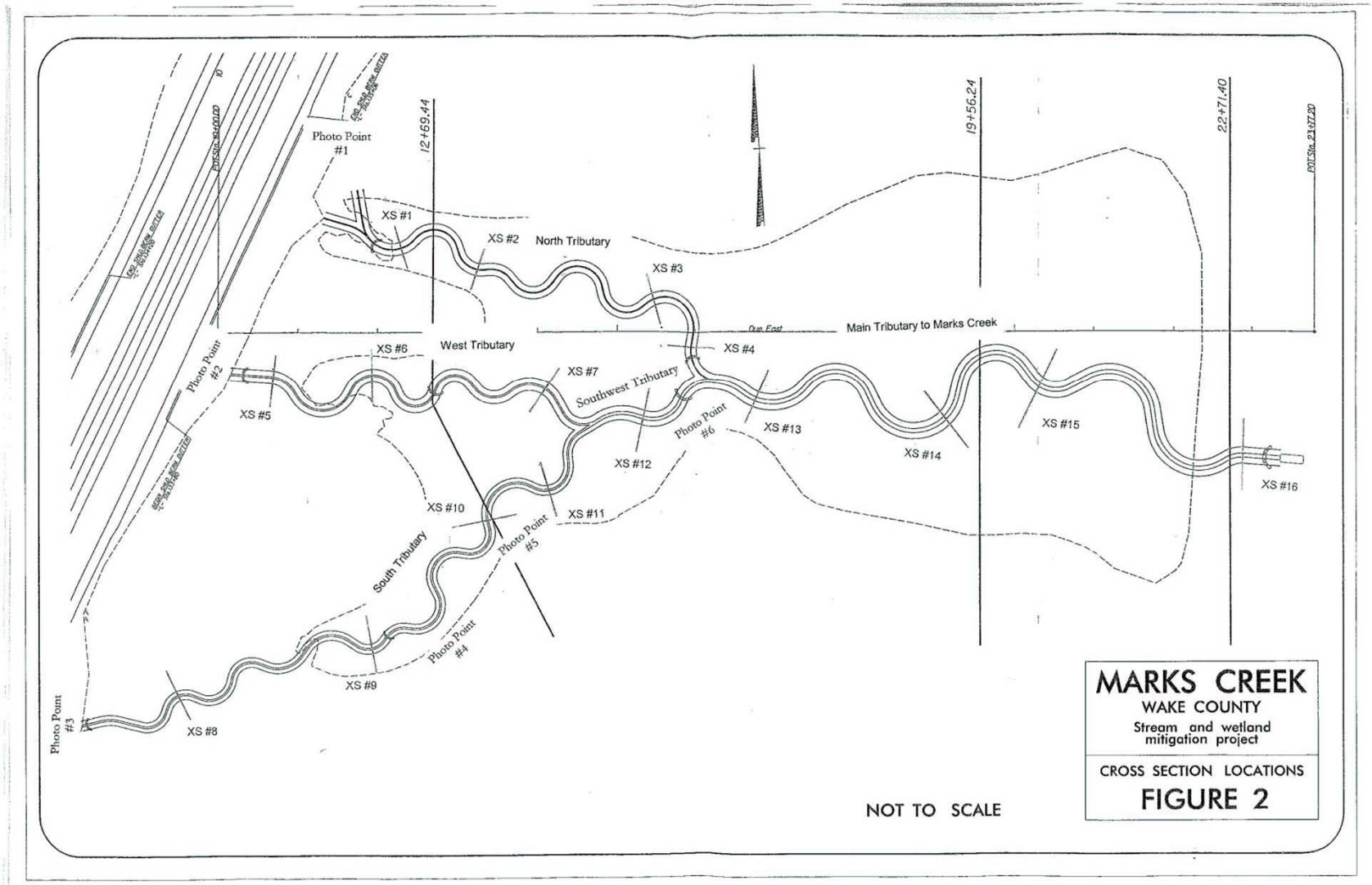


Photo Point #1
12+69.44
19+56.24
22+71.40
XS #1
XS #2
North Tributary
XS #3
Main Tributary to Marks Creek
West Tributary
XS #4
XS #6
XS #7
Southwest Tributary
Photo Point #2
XS #5
XS #12
Photo Point #6
XS #13
XS #14
XS #15
XS #16
XS #10
XS #11
South Tributary
Photo Point #5
Photo Point #4
XS #9
Photo Point #3
XS #8
MARKS CREEK
WAKE COUNTY
Stream and wetland mitigation project
CROSS SECTION LOCATIONS
FIGURE 2
NOT TO SCALE

2.3 Results of the Stream Assessment

2.3.1 Site Data

The assessment included the survey of sixteen previously established cross sections across the four streams and the longitudinal profile of the four streams. The length of the profile along the main tributary of Marks Creek was approximately 970 linear feet. The profiles associated with the North, West, South, and Southwest Tributaries were approximately 700 linear feet, 550 linear feet, 960 linear feet, and 180 linear feet, respectively. Stationing started at 10+00 along all of the tributaries. Cross section locations were subsequently based on the stationing of the longitudinal profile and are presented below. Morphological data comparisons are shown in Table 1.

North Tributary (Stations 10+00 through 17+00)

- Cross Section #1. North Tributary, Station 11+52, riffle section
- Cross Section #2. North Tributary, Station 12+34, riffle section
- Cross Section #3. North Tributary, Station 14+68, run section
- Cross Section #4. North Tributary, Station 16+65, pool section

West Tributary (Stations 10+00 through 15+50)

- Cross Section #5. West Tributary, Station 11+72, riffle section
- Cross Section #6. West Tributary, Station 12+89, pool section
- Cross Section #7. West Tributary, Station 14+72, riffle section

South Tributary (Stations 10+00 through 19+60)

- Cross Section #8. South Tributary, Station 11+34, run section
- Cross Section #9. South Tributary, Station 14+18, pool section
- Cross Section #10. South Tributary, Station 17+38, riffle section
- Cross Section #11. South Tributary, Station 18+59, run section

Southwest Tributary (Stations 10+00 through 11+80)

- Cross Section #12. Southwest Tributary, Station 10+30, run section

Main Tributary (Stations 10+00 through 19+70)

- Cross Section #13. Main Tributary, Station 10+78, riffle section
- Cross Section #14. Main Tributary, Station 14+60, pool section
- Cross Section #15. Main Tributary, Station 16+37, run section
- Cross Section #16. Main Tributary, Station 19+52, run section

The location of all sixteen cross sections was established during the 2004 monitoring period. No cross sectional surveys were completed prior to 2004 at the Marks Creek site. Comparisons between Year 2004 and 2005 data are shown in Table 1 below and summarized in Appendix B. Future survey data may vary depending on actual location of rod placement and alignment; however, the information should remain similar in overall appearance.

Table 1. Morphological Comparisons for North Tributary - Cross Sections #1 through #4								
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #1 Station 11+57 (Riffle Section)**	**Cross Section #2 Station 12+34 (Riffle Section)**	**Cross Section #3 Station 14+68 (Run Section)**	**Cross Section #4 Station 16+65 (Pool Section)**	**Min. - Max. (Riffle Sections Only)**	
			2005	**2005**	**2005**	**2005**	**2004**	**2005**
Drainage Area (sq. mi)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Bankfull Width (ft)	15.0	13.0	11.5	19.6	13.7	9.5	11.7 - 15.2	11.5 - 19.6
Bankfull Mean Depth (ft)	1.0	0.8	0.6	0.4	0.5	1.1	0.5 - 0.7	0.4 - 0.6
Width/Depth Ratio	15.0	17.0	>15.0	>15.0	>15.0	8.6	>15.0	>15.0
Bankfull Cross Sectional Area (sq. ft)	8.0	10.0	7.1	7.5	7.1	10.1	7.2 - 7.9	7.1 - 7.5
Maximum Bankfull Depth (ft)	1.85	1.4	1.2	1.0	1.2	1.7	0.9 - 1.1	1.0 - 1.2
Floodprone Area Width (ft)	50.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	3.33	3.8	>8.7	>5.1	>7.3	>10.0	>6.6	>5.1
Average Slope	0.011	0.008	0.165	0.165	0.165	0.165	0.165	0.165
Bank Height Ratio	N/A	N/A	1.0	1.0	1.0	1.3	1.0	1.0
Particle Sizes								
D16 (mm)	N/A	N/A	0.22	0.45	1.1	0.52	0.45 - 0.59	0.22 - 0.45
D35 (mm)	N/A	N/A	0.64	2.9	1.5	0.8	1.3 - 3.8	0.64 - 2.9
D50 (mm)	0.062 - 2.0	N/A	2.0	6.6	1.8	1.0	2.0 - 14.0	2.0 - 6.6
D84 (mm)	N/A	N/A	22.0	23.0	23.0	1.8	20.0 - 24.0	22.0 - 23.0
D95 (mm)	N/A	N/A	30.0	30.0	30.0	1.9	29.0 - 30.0	30.0
Stream Classification (Riffle Sections Only)	C5	C5	C4	C4	N/A	N/A	C4	C4

Table 2. Morphological Comparisons for West Tributary - Cross Sections #5 through #7							
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #5 Station 11+72 (Riffle Section)**	**Cross Section #6 Station 12+89 (Pool Section)**	**Cross Section #7 Station 14+72 (Riffle Section)**	**Min. - Max. (Riffle Sections Only)**	
			2005	**2005**	**2005**	**2004**	**2005**
Drainage Area (sq. mi)	0.3	0.3	0.3	0.3	0.3	0.3	0.3
Bankfull Width (ft)	16.0	13.0	13.1	7.7	13.3	14.3 - 14.9	13.1 - 13.3
Bankfull Mean Depth (ft)	1.1	0.8	0.8	1.4	0.8	0.7	0.8
Width/Depth Ratio	15.0	16.0	>15.0	5.7	>15.0	>15.0	>15.0
Bankfull Cross Sectional Area (sq. ft)	16.8	10.5	10.3	10.3	10.2	9.6 - 10.5	10.2 - 10.3
Maximum Bankfull Depth (ft)	1.9	1.5	1.2	2.3	1.8	1.3 - 1.4	1.2 - 1.8
Floodprone Area Width (ft)	50.0	>50.0	>100.0	35.0	>100.0	>100.0	>100.0
Entrenchment Ratio	3.13	3.8	>7.6	4.6	>7.5	>6.7	>7.5
Average Slope	0.005	0.005	0.013	0.013	0.013	0.013	0.013
Bank Height Ratio	N/A	N/A	1.0	1.6	1.0	1.0 - 1.1	1.0
Particle Sizes							
D16 (mm)	N/A	N/A	1.2	0.48	1.4	0.60 - 0.71	1.2 - 1.4
D35 (mm)	N/A	N/A	1.8	1.1	2.0	1.4 - 5.0	1.8 - 2.0
D50 (mm)	0.062 - 2.0	N/A	2.8	1.6	3.5	8.0	2.8 - 3.5
D84 (mm)	N/A	N/A	15.0	20.0	13.0	16.0 - 22.0	13.0 - 15.0
D95 (mm)	N/A	N/A	29.0	31.0	20.0	20.0 - 42.0	20.0 - 29.0
Stream Classification (Riffle Sections Only)	C5	C5	C4	N/A	C4	C4	C4

Table 3. Morphological Comparisons for South Tributary - Cross Sections #8 through #11								
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #8 Station 11+34 (Run Section)**	**Cross Section #9 Station 14+18 (Pool Section)**	**Cross Section #10 Station 17+38 (Riffle Section)**	**Cross Section #11 Station 18+59 (Run Section)**	**Riffle Comparison**	
			2005	**2005**	**2005**	**2005**	**2004**	**2005**
Drainage Area (sq. mi)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Bankfull Width (ft)	12.0	13.0	11.9	6.6	35.1	26.3	27.6	35.1
Bankfull Mean Depth (ft)	0.8	0.7	0.5	1.1	0.2	0.2	0.3	0.2
Width/Depth Ratio	15.0	18.0	>15.0	6.0	>15.0	>15.0	>15.0	>15.0
Bankfull Cross Sectional Area (sq. ft)	9.9	9.0	6.3	7.1	7.4	6.1	7.2	7.4
Maximum Bankfull Depth (ft)	1.4	1.3	1.0	1.7	0.6	0.8	0.8	0.6
Floodprone Area Width (ft)	50.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	4.17	3.8	>8.4	>10.0	>2.8	>3.8	>3.6	>2.8
Average Slope	0.006	0.006	0.013	0.013	0.013	0.013	0.013	0.013
Bank Height Ratio	N/A	N/A	1.5	1.4	1.1	1.0	1.0	1.1
Particle Sizes								
D16 (mm)	N/A	N/A	0.18	0.27	<0.062	<0.062	<0.062	<0.062
D35 (mm)	N/A	N/A	0.32	0.32	<0.062	<0.062	0.21	<0.062
D50 (mm)	0.062 - 2.0	N/A	0.49	0.42	<0.062	<0.062	0.45	<0.062
D84 (mm)	N/A	N/A	2.8	2.3	0.34	<0.062	1.1	0.34
D95 (mm)	N/A	N/A	9.0	10.0	0.52	0.11	1.7	0.52
Stream Classification (Riffle Sections Only)	C5	C5	N/A	N/A	C6	N/A	C5	C6

Table 4. Morphological Comparisons for Southwest and Main Tributaries - Cross Sections #12 through #16									
Variable	**Mitigation Plan**	**As-Built**	**Cross Section #12 Station 10+30 (Run Section)**	**Cross Section #13 Station 10+78 (Riffle Section)**	**Cross Section #14 Station 14+60 (Pool Section)**	**Cross Section #15 Station 16+37 (Run Section)**	**Cross Section #16 Station 19+52 (Run Section)**	**Riffle Comparison**	
			2005	**2005**	**2005**	**2005**	**2005**	**2004**	**2005**
Drainage Area (sq. mi)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Bankfull Width (ft)	20.0	13.0	28.4	16.7	9.1	17.7	16.7	16.5	16.7
Bankfull Mean Depth (ft)	1.4	0.7	0.2	0.6	1.2	0.6	1.0	0.7	0.6
Width/Depth Ratio	14.0	18.0	>15.0	>15.0	7.6	>15.0	>15.0	>15.0	>15.0
Bankfull Cross Sectional Area (sq. ft)	31.3	9.0	6.5	10.7	10.7	10.5	15.9	10.7	10.7
Maximum Bankfull Depth (ft)	2.5	1.3	0.9	1.0	2.0	1.4	1.6	1.0	1.0
Floodprone Area Width (ft)	60.0	>50.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0	>100.0
Entrenchment Ratio	3.00	3.8	>3.5	>6.0	>10.0	>5.6	>6.0	>6.1	>6.0
Average Slope	0.004	0.006	0.017	0.004	0.004	0.004	0.004	0.004	0.004
Bank Height Ratio	N/A	N/A	1.0	1.3	1.4	1.0	1.1	1.1	1.3
Particle Sizes									
D16 (mm)	N/A	N/A	1.1	4.8	0.55	0.15	0.32	0.19	4.8
D35 (mm)	N/A	N/A	6.1	16.0	0.72	1.8	1.5	1.3	16.0
D50 (mm)	0.062 - 2.0	N/A	13.0	18.0	0.9	17.0	17.0	8.1	18.0
D84 (mm)	N/A	N/A	28.0	29.0	1.6	29.0	27.0	24.0	29.0
D95 (mm)	N/A	N/A	30.0	39.0	1.8	31.0	31.0	31.0	39.0
Stream Classification (Riffle Sections Only)	C5	C5	N/A	C4	N/A	N/A	N/A	C4	C4

Pebble counts were taken at each cross section as a means of determining the extent of change in bed material over the five year monitoring period. Comparisons between Year 2004 and Year 2005 pebble count data are shown in Table 1. The pebble counts taken during the Year 2005 monitoring period noted that the overall D_{50} (50 percent of the sampled population is equal to or finer than the representative particle diameter) decreased in size with regard to the data collected along the cross sections associated with the North, West and South Tributaries. The exceptions being the pools associated with Cross Sections #4 and #6. They remained consistent. The opposite was observed for the Southwest and Main Tributaries. Overall, the D_{50} associated with these two reaches increased in size with the exception of Cross Section #15, which decreased in size. Due to the abnormally dry year associated with 2005, sediment transport functions were likely reduced causing an increase in the amount of fines not being effectively transported through the system. Considering the intended design for this sand-bed system, the existing particle size distributions appear to be nearing the ranges originally proposed. Bedload monitoring will continue for the next several years providing a better range of data for comparison purposes.

Five charts depicting the particle size distributions for the North, West, South, Southwest and Main Tributaries are presented below.

Chart 1.

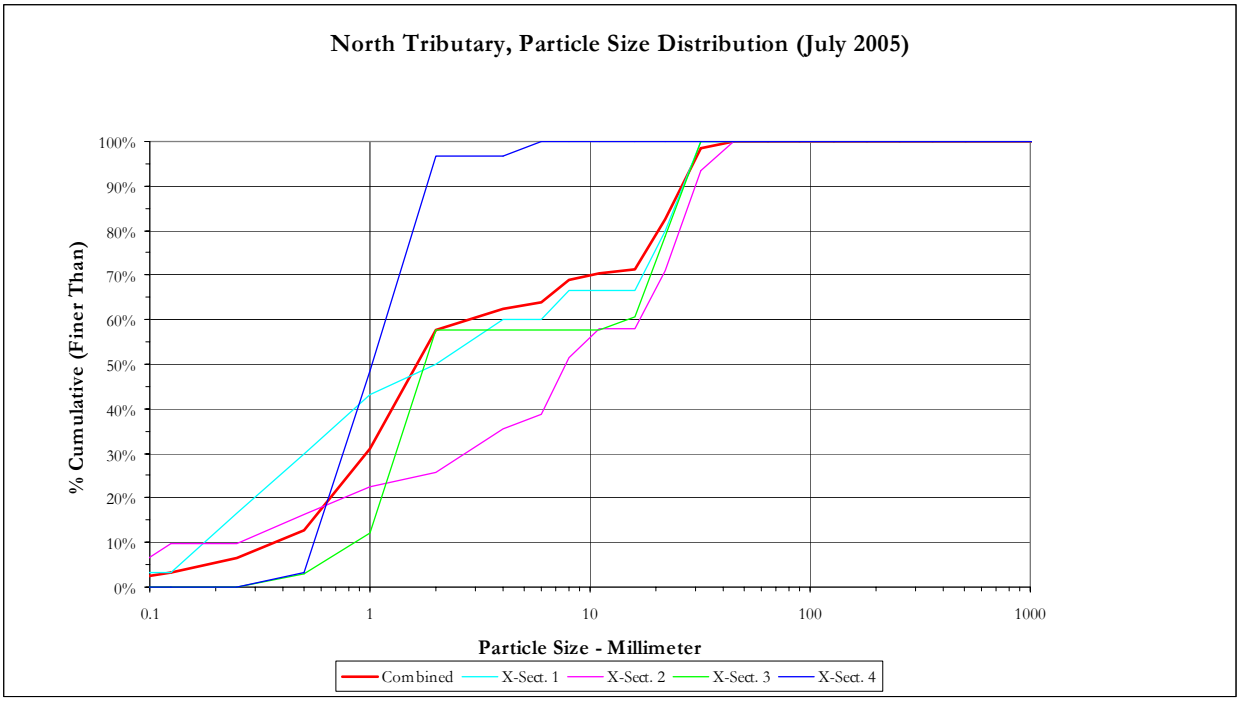


Chart 2.

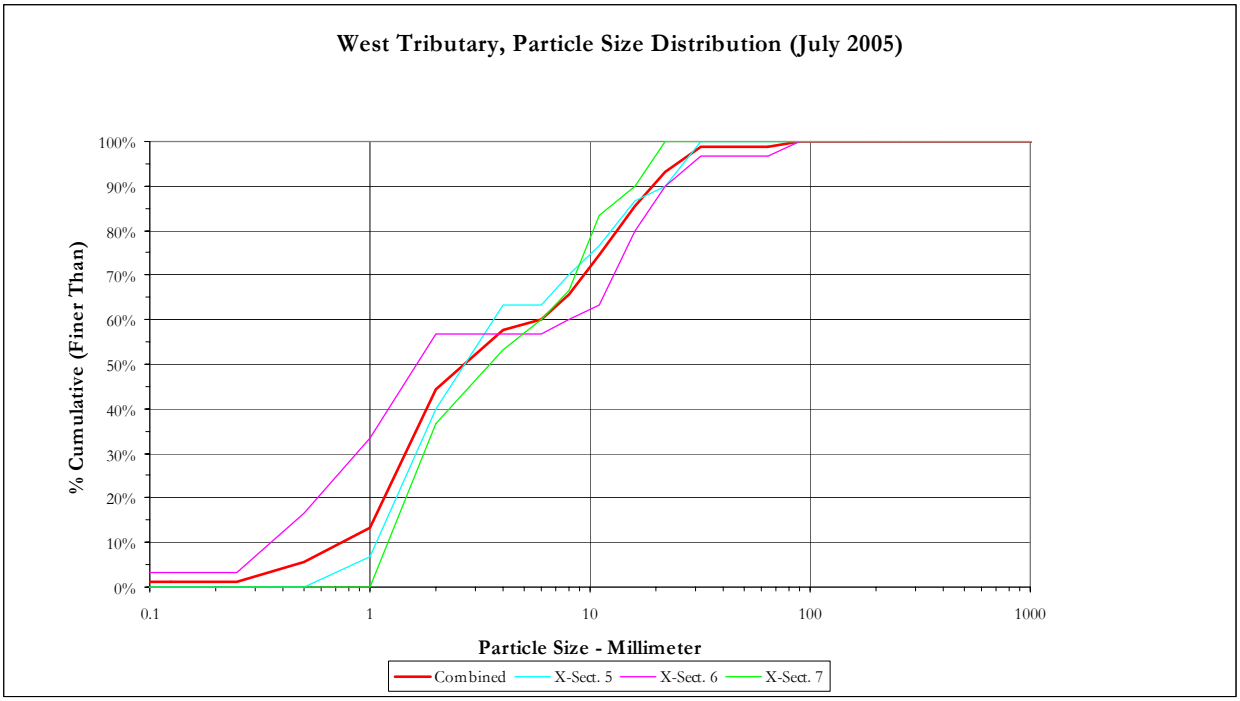


Chart 3.

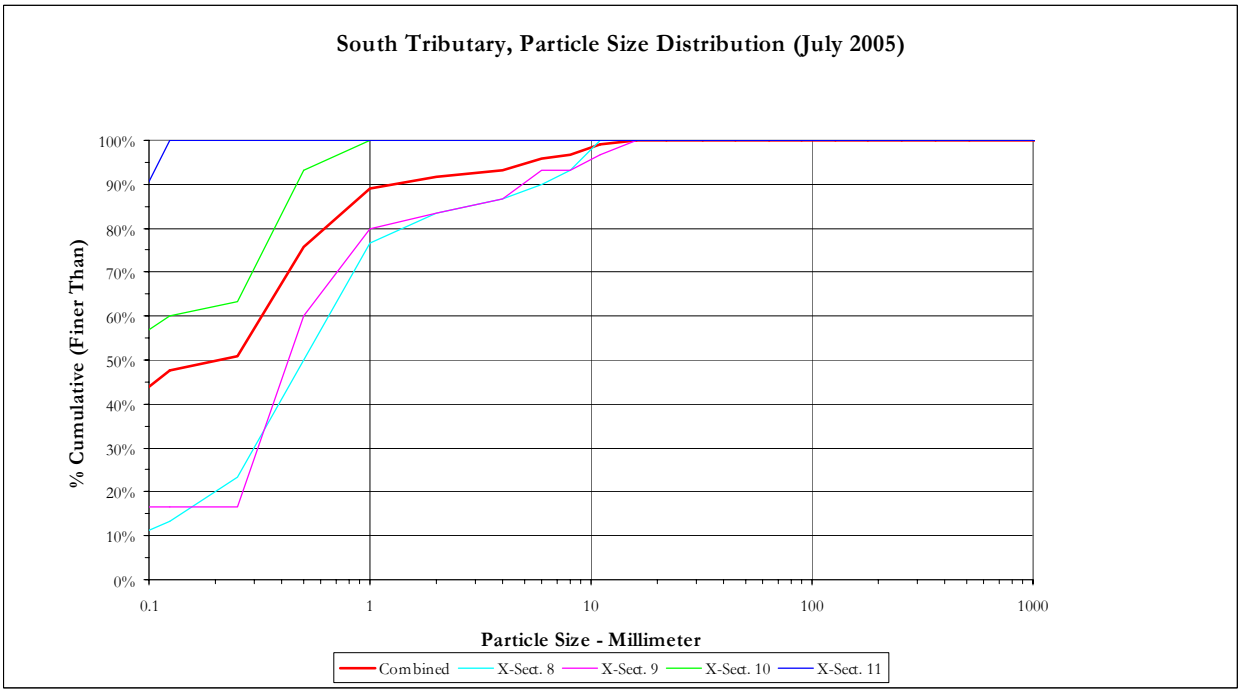


Chart 4.

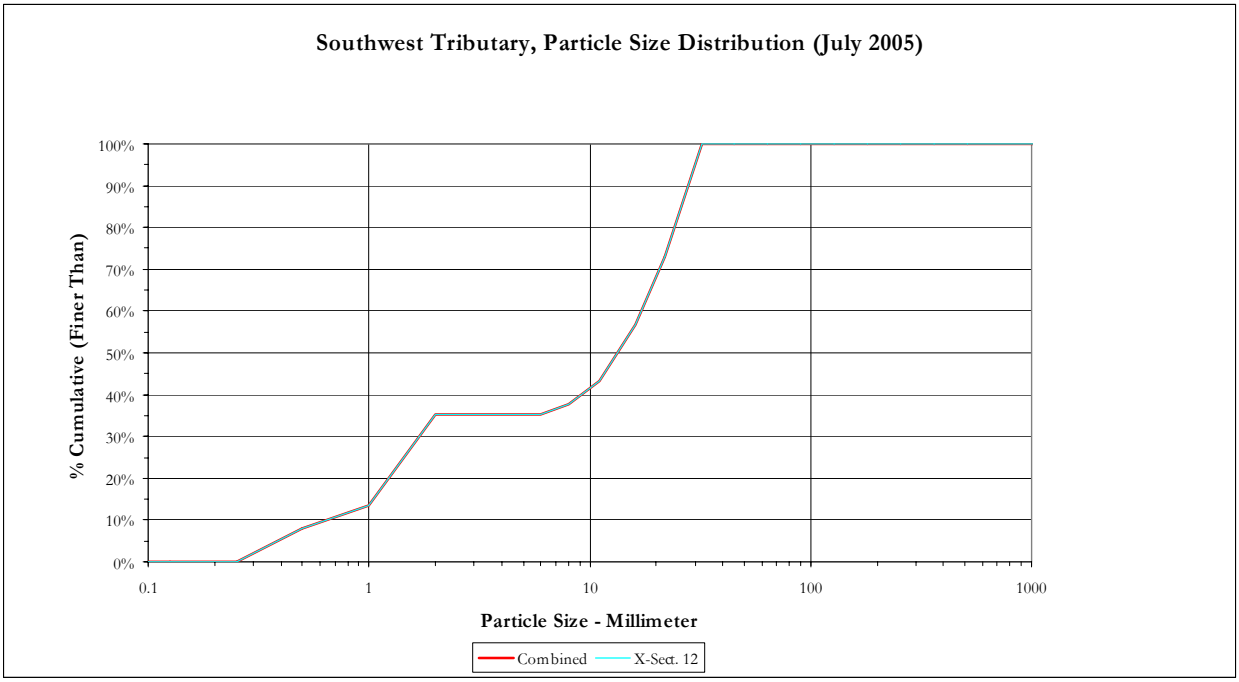
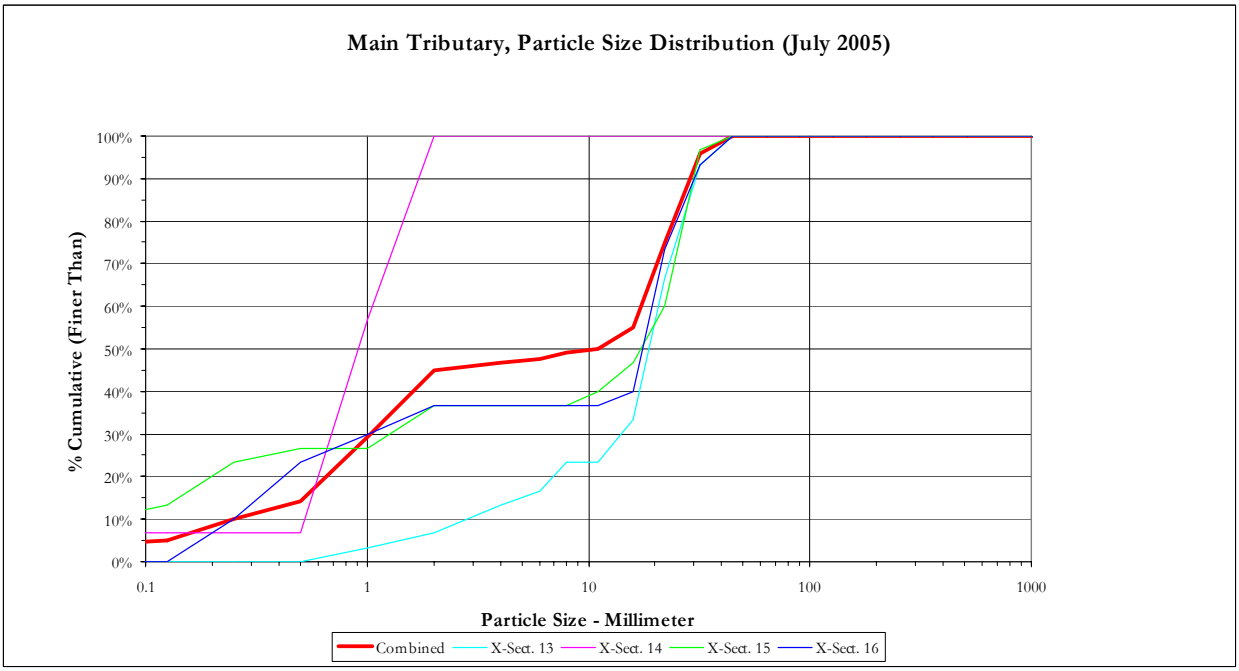


Chart 5.



Longitudinal profile surveys were conducted on all five stream reaches associated with the Marks Creek Site. Bank stability was assessed during the cross section and longitudinal profile surveys. Several areas of deposition and active scouring were observed; however, none warrant immediate remedial actions. Descriptions and evaluations of these areas are as follows:

North Tributary (Stations 10+00 through 17+00)

- Station 10+00 through Station 12+34. This portion of the reach appears to be properly functioning. No problem areas or potential problem areas were observed.
- Station 12+34 through Station 16+15. The stream is heavily vegetated throughout this area both within and outside of the bankfull channel confines. This area will continue to be assessed during each monitoring period to ensure that it does not negatively affect the overall integrity of the system.
- Station 13+63. Active scouring along the right stream bank appears to have undercut the existing log vane. Localized erosion was observed; however, it is not compromising the overall reach or the overall function of the project area. This area will be re-assessed during the next monitoring period.
- Station 16+15 through Station 17+00. This portion of the reach appears to be properly functioning. No problem areas or potential problem areas were observed.

West Tributary (Stations 10+00 through 15+50)

- Station 10+00 through Station 11+07. This portion of the reach appears to be properly functioning. No problem areas or potential problem areas were observed.
- Station 11+07 through Station 12+70. The stream is heavily vegetated throughout this area both within and outside of the bankfull channel confines. This area will continue to be assessed during each monitoring period to ensure that it does not negatively affect the overall integrity of the system.
- Station 13+00. Localized erosion was observed along the right stream bank. It does not appear to be adversely affecting the remaining portion of this reach. This area will be reassessed during next year's monitoring activities.
- Station 13+18. Active scouring was observed along the right stream bank in the vicinity of the cross vane structure. This area is localized and does not appear to be compromising the remainder of the reach. It will be re-assessed during the next monitoring period.
- Station 13+35 through Station 15+55. The stream is heavily vegetated throughout this area both within and outside of the bankfull channel confines. This area will continue to be assessed during each monitoring period to ensure that it does not negatively affect the overall integrity of the system.

South Tributary (Stations 10+00 through 19+60)

- Station 10+00 through Station 14+20. This portion of the reach appears to be properly functioning. No problem areas or potential problem areas were observed.

- Station 14+20 through Station 19+70. Dense vegetative growth was observed throughout the existing bankfull channel confines. A comparison of cross section surveys conducted between 2004 and 2005 noted minor aggradation at Cross Section #10 (Station 17+38); however, the overall channel dimension remains defined. This area will continue to be assessed during each monitoring period to ensure it does not compromise the overall functions of the reach.

Southwest Tributary (Stations 10+00 through 11+80)

- Station 10+00 through Station 11+00. The stream is heavily vegetated throughout this area both within and outside of the bankfull channel confines. This area will continue to be assessed during each monitoring period to ensure that it does not negatively affect the overall integrity of the system.
- Station 11+00 through Station 11+80. This portion of the reach appears to be properly functioning. No problem areas or potential problem areas were observed.

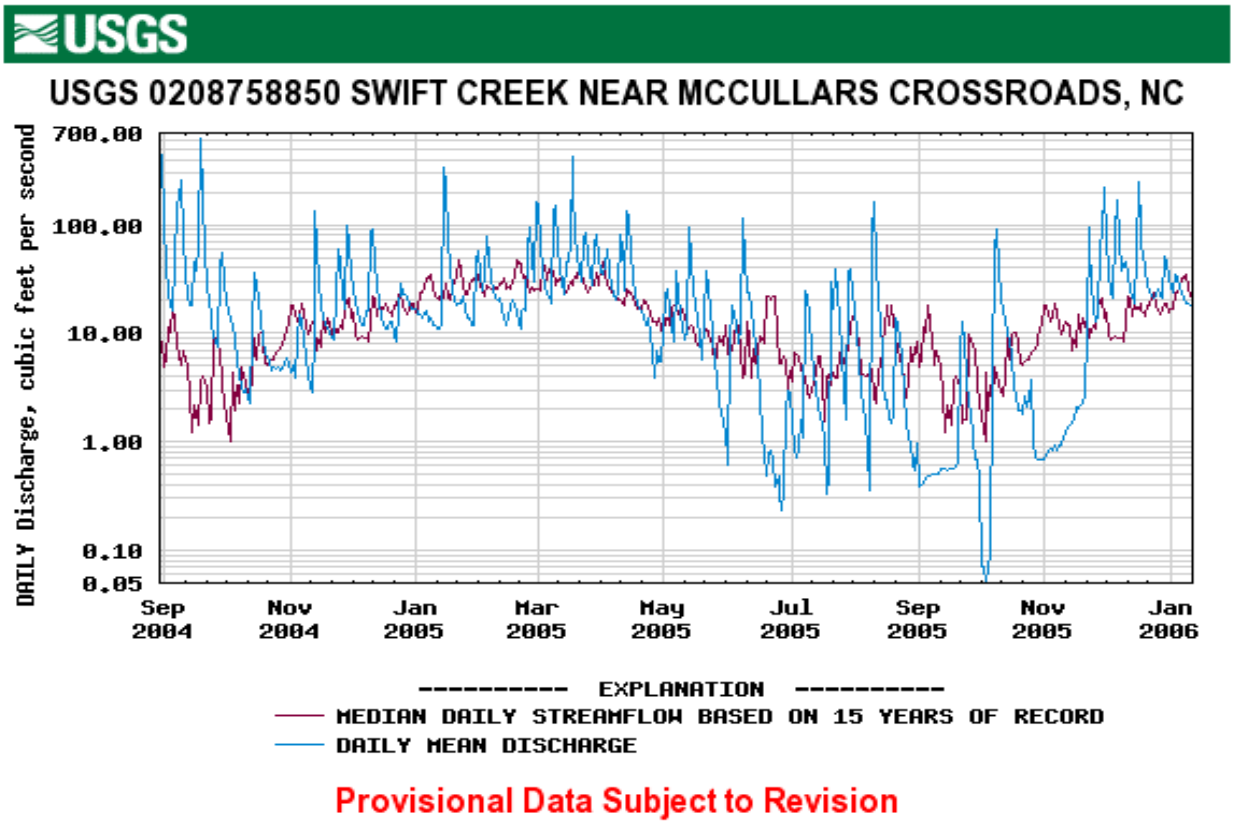
Main Tributary (Stations 10+00 through 19+70)

- Station 10+00 through Station 19+70. The main tributary appears to be properly functioning. No problem areas or potential problem areas were observed.

2.3.2 Climatic Data

Monitoring requirements state that at least two bankfull events must be documented through the five-year monitoring period. No surface water gages exist along Marks Creek or its tributaries. A review of known USGS surface water gages identified one rural stream gage station within fifteen miles of the mitigation site. This gage station is identified as Swift Creek near McCullars Crossroads. The Swift Creek gage station has a drainage area of 35.8 square miles and is located approximately 15 miles southeast of the mitigation site near the confluence of Swift Creek and Lake Wheeler

The Swift Creek gage accurately reflects the hydrology and precipitation in the project area. It is situated in USGS Hydrologic Unit 03020201. Datum of the gage is 251.46 feet above sea level NGVD29. Based on the drainage area associated with the gage, the correlated bankfull discharge according to the NC Rural Piedmont Regional Curves (USACE, 2003) is between 770 and 1,760 cubic feet per second (cfs). Following Year 2004 monitoring activities, a review of peak flows was conducted for the period between July 2002 and July 2004. Reviews were also conducted for the Year 2005 activities. According to USGS data, Marks Creek met its requirement of two bankfull events during the first year of monitoring, with both of the events happening in 2003. The USGS graph depicting peak flows during 2005 is presented below. No bankfull events were recorded at the gage during 2005.



2.4 Conclusions

Based on the results obtained as part of the Year 2005 monitoring activities, the Marks Creek Site continues to function within the capacity for which it was designed. Significant problems were endured during 2003 as a result of erosion control problems associated with the construction of the US 64 Knightdale Bypass, immediately upstream of the project area. All five unnamed tributaries were inundated with sediment. NCDOT postponed the Year 2003 monitoring to allow the site to stabilize. Formal monitoring was initiated in 2004. According to the data collected in 2005, areas of deposition and scour continue to exist along the North, West, Southwest, and Main Tributaries; however, these areas remain localized and do not appear to be compromising the overall functions of the site. Due to the abnormally low amounts of precipitation experienced during 2005, excessive sediment was noted along portions of the South Tributary, which remains consistent with the data collected in 2004. It is anticipated that future bankfull events will help to move this sediment through the system. Overall, the system remains intact. No remedial work is proposed or needed at the current time.

Based on the information obtained from the USGS, the Marks Creek Site has met the required monitoring protocols for hydrology as it relates to bankfull events. At least two bankfull events have occurred on site since the time of construction.

Based on the data collected in 2005, the Marks Creek Site continues to improve in overall quality and function. An on-site agency meeting was held in August 2005 to review the site. During the on-site meeting, the stream mitigation portion of the project was discussed. No

problems were currently noted with respect to the stream channels and NCDOT will continue to monitor the site.

3.0 REFERENCES

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